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AN INDEX OF HARDINESS IN PEACH BUDS

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The effect of various environmental conditions on hardiness of the peach is an important question to the fruit grower, but a thorough study of this subject can not be made until some criterion is found for determining the degree of hardiness. A most desirable criterion would be some physical or chemical measurement in which personal judgment is reduced to a minimum. After such a measuring unit has been found it will then be possible to determine more accurately the effect of environmental conditions on hardiness and the degree of hardiness in different varieties growing under the same conditions.

Ohlweiler,[1] Chandler,[2] and a number of other workers have found a correlation between the density of cell sap and the resistance of the plant to low temperatures. In measuring osmotic pressures and freezing point lowerings of expressed cell saps a number of important conditions are necessarily neglected. The size and shape of cells and the properties of the colloids present undoubtedly exert a most important influence. On the former depend the size and shape of capillary water films and on the latter the amount of water held by imbibition. Both limit the degree of hardiness of the tissue. These facts may in part explain the lack of correlation observed by other workers such as Salmon and Fleming,[3] who state that:

"There appears to be no relation between the cryoscopic value of the extracted sap of winter rye, wheat, emmer, barley, and oats grown in the field with normal conditions and their ability to resist winter killing. Turgidity of the tissue as influenced by physiological drought appears to have more influence than the kind of grain on the concentration of the cell sap. Harris and his co-workers[4] have pointed out that the environmental conditions under which the plant grows seem to modify the osmotic pressure of the cell sap."

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[1] Ohlweiler, W. W. The relation between the density of cell sap and the freezing points of leaves. Rep. Mo. Bot. Gard. 23: 101–131. 1912.

[2] Chandler, W. H. The killing of plant tissue by low temperature. Mo. Agr. Exp. Sta. Res. Bull. 8. 1913.

[3] Salmon, S. C., and Fleming, F. L. Relation of the density of cell sap to winter hardiness in small grains. Journ. Agr. Res. 13: 497–506. 1918.

[4] Harris, J. A. On the osmotic concentration of the tissue fluids of phanerogamic epiphytes. Amer Journ. Bot. 5: 490–506. 1918. Harris, J. A., and Lawrence, J. V., with the coöperation of R. A. Gortner. The cryoscopic constants of expressed vegetable saps as related to local environmental conditions in the Arizona deserts. Physiol. Res. 2: 1–49. 1916.

Beach and Allen[5] state that maturity bears an important relation to hardiness and that the amount of moisture present in tissues is an important factor relating to maturity. These writers found that the moisture content is slightly lower in twigs of the more hardy apple varieties than in tender ones. Shutt[6] gives a series of determinations of moisture content of apple twigs which compares very favorably with a series arranged according to hardiness, the more tender containing the greater percentage of water. Thayer[7] notes the general rule that buds on young trees are more apt to be injured than those on more matured trees. This is no doubt closely related to the water content of the tissues. Daily variation in water content of leaves and twigs has been observed in several cases,[8] and in all probability a change in water content of plant tissues and organs is a most important factor influencing the response of the plant to its environment.

An experiment was carried out in the winter of 1918–1919 with the object of determining the moisture content of fruit buds taken from two varieties of peach, one of which is commonly considered relatively more hardy than the other. The two varieties selected for this study were the Elberta and Greensboro. Fifteen trees of each variety chosen for this work formed part of a nine-acre peach orchard. Four trees of each variety were situated on high ground, three on low ground, and seven trees were growing under various fertilizer treatments. Beginning with November 8, 1918, and thereafter at monthly intervals, except for the last period which was three weeks in length, buds were collected from these trees. The samples were taken from the same marked branches of the selected trees on clear days that were preceded by at least one clear day. This precaution was taken in order to avoid getting the buds when they were in an excessive moist condition following a rain or fog. Likewise, the afternoon was selected as the time of day for collecting the samples. The samples were immediately placed in small medicine vials with screw caps and weighed the following day in the laboratory. Each sample consisted of ten fruit buds. After determining the green weights, the buds were placed in a vacuum electric oven and dried to constant weight at a temperature of approximately 82° C. and a partial vacuum of 40 to 65 cm. of mercury. The drying usually required from 14 to 18 hours. The dry weights were then determined.

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[5] Beach, S. A., and Allen, F. W., Jr. Hardiness in the apple as correlated with structure and composition. Iowa Agr. Exp. Sta. Res. Bull. 21. 1915.

[6] Shutt, F. T. On the relation of moisture-content to hardiness in apple twigs. Proc. & Trans. Roy. Soc. Canada, II. **9**: sec. 4: 149–153. 1903.

[7] Thayer, P. Winter killing of peach buds. Ohio Agr. Exp.Sta. Mo. Bull. **1**: 311–312. 1916.

[8] Livingston, B. E., and Brown, W. H. Relation of the daily march of transpiration to variations in water content of foliage leaves. Bot. Gaz. **53**: 309–330. 1912. Lloyd, F. E. The relation of transpiration and stomatal movements to the water content of leaves in *Fouquieria splendens*. Pl. World **15**: 1–14. 1912. Shreve, Edith B. The daily march of transpiration in a desert perennial. Carnegie Inst. Wash. Publ. 194. 1914.

Data showing the seasonal variation in the average green weight, dry weight, ratio of water content to green weight, and ratio of water content to dry weight of buds taken from the fifteen trees of the two varieties are presented in table 1. The arrangement is such that corresponding values of the two varieties may be easily compared as well as the values for different periods. The average green and dry weights represent the weights of ten buds. With the exception of the average dry weights of buds collected on November 8, all values representing the Elberta variety are greater than those representing the Greensboro. These higher values are mostly due to the greater amount of water contained in the buds. (It is assumed that in the drying process the amount of water lost makes up the largest part of the substances driven off and that no oxidation processes have taken place to change appreciably the dry weight values.) Both the green and dry weights of each variety increase month by month, slowly during the winter, but very rapidly in early spring.

TABLE 1. *Data showing seasonal variation in average green weight, average dry weight, average ratio of moisture content to green weight, and average ratio of moisture content to dry weight of fruit buds of the Elberta and the Greensboro peach.*

Date Samples Were Collected	Ave. Green Weight		Ave. Dry Weight		Ratio of Water Content to Green Weight		Ratio of Water Content to Dry Weight	
	Elberta	Gr'boro	Elberta	Gr'boro	Elberta	Gr'boro	Elberta	Gr'boro
	Grams	*Grams*	*Grams*	*Grams*				
November 8	.124	.121	.073	.073	.41	.40	.69	.65
December 6	.144	.129	.079	.073	.46	.43	.84	.76
January 7	.144	.123	.082	.075	.43	.38	.76	.62
February 7	.164	.128	.082	.075	.49	.42	.99	.71
March 7	.327	.220	.115	.092	.65	.58	1.85	1.37
March 28	1.050	.750	.205	.180	.80	.76	4.12	3.17

The differences between the values of the two varieties as well as the seasonal variations of each are perhaps more clearly seen in figures 1 and 2, representing these same data plotted as ordinates. Time periods are shown as abscissas. The seasonal variation in dry weight is small in comparison with that of green weight. Increase in green weight is thus seen to be apparently due to the water. The ratio graphs (fig. 2) based on dry weight show greater seasonal variations and greater differences between the two varieties than those based on green weight.

Ratios of water content to dry weight of fruit buds from individual trees are given in table 2 in order to facilitate comparison between trees of the two varieties that were similarly situated. The first seven trees had received fertilizer treatment about May 1 of each of the three preceding years. The fertilizers used were acid phosphate (16 percent), muriate of potash, and nitrate of soda, represented by *P*, *K*, and *N* respectively. Whether used singly or in combination, the same amount of each fertilizer was applied per tree receiving such treatments. These amounts were:

2 pounds of acid phosphate, 1 pound of muriate of potash, and 1½ pounds of nitrate of soda. The check trees receiving no fertilizers are designated by the letters *C* and *CH*. Trees growing on high ground are represented by the letter *H* and those on low ground by *L*. The trees treated with fertilizers were on comparatively high ground, and one of the check trees

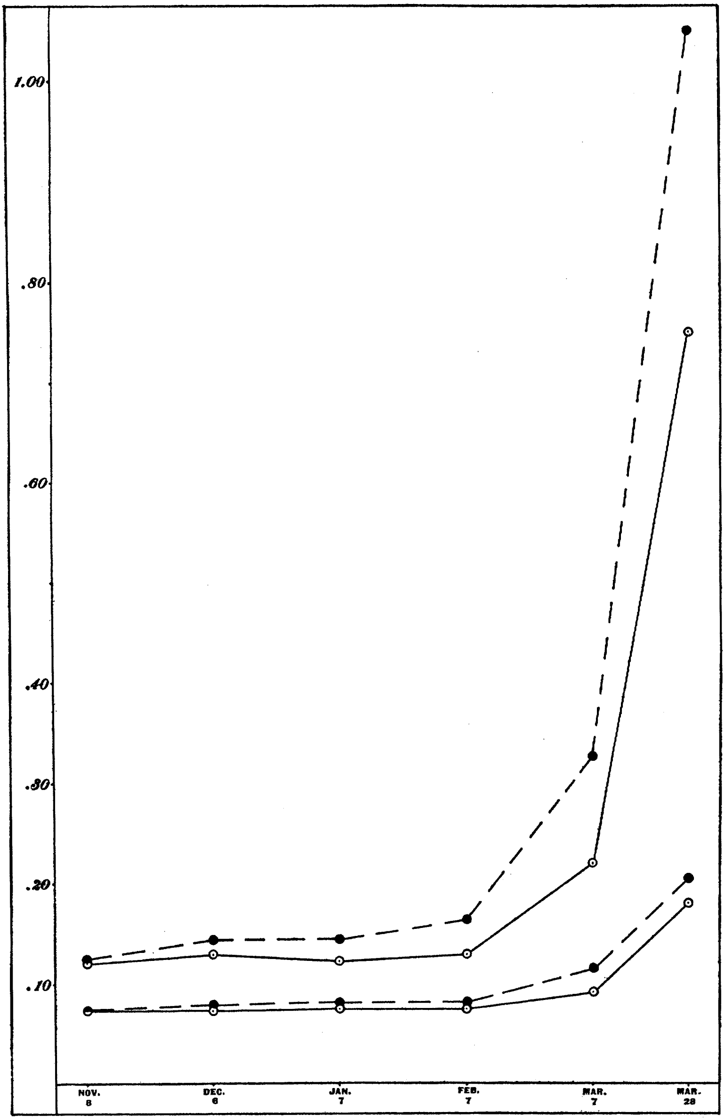

FIG. 1. Graphs showing seasonal variation in green weight (upper pair) and dry weight (lower pair) of Elberta (broken lines) and Greensboro (continuous lines) fruit buds.

(*CH*) is included in the group growing on high ground. In all but two cases, trees of the two varieties designated by the same letter were growing 18

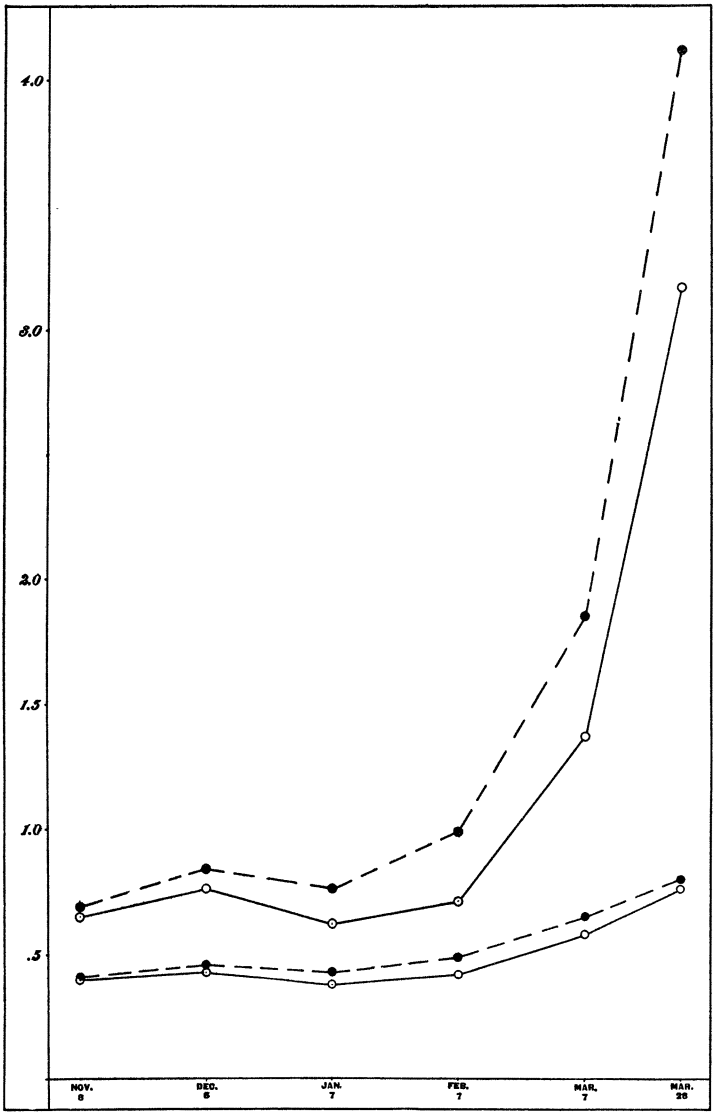

FIG. 2. Graphs showing seasonal variation in ratio of water content to dry weight (upper pair) and ratio of water content to green weight (lower pair) of fruit buds in the Elberta (broken lines) and Greensboro (continuous lines) peach.

feet apart. In the two exceptions the trees were within 38 feet of each other.

TABLE 2. *Data showing seasonal variations in ratio of water content to dry weight of fruit buds from individual trees of the varieties Elberta and Greensboro.*

Tree	November 8		December 6		January 7		Feburary 7		March 7		March 28	
	E	G	E	G	E	G	E	G	E	G	E	G
P.	.68	.63	.82	.79	.74	.63	.98	.71	1.80	1.35	4.21	3.30
K.	.67	.66	.82	.73	.76	.60	1.00	.68	1.86	1.24	4.23	2.91
N.	.65	.58	.82	.73	.72	.56	.89	.71	1.68	1.36	3.76	3.45
PK.	.70	.67	.85	.73	.81	.62	1.10	.69	1.97	1.24	4.28	2.75
PN.	.70	.64	.88	.74	.83	.60	1.07	.70	1.97	1.44	4.21	3.11
KN.	.75	.69	.89	.78	.82	.66	1.20	.72	2.01	1.32	4.18	3.22
PKN.	.81	.66	.90	.78	.86	.67	1.11	.83	1.95	1.39	4.07	3.00
Ave. .	.71	.65	.85	.75	.79	.62	1.05	.72	1.89	1.33	4.13	3.11
C.	.74	.66	.89	.75	.76	.54	.97	.70	1.97	1.29	4.19	3.61
CH.	.74	.61	.85	.74	.72	.60	.99	.70	1.94	1.34	4.19	2.95
Ave. .	.74	.64	.87	.75	.74	.57	.98	.70	1.96	1.32	4.19	3.28
CH.	.74	.61	.85	.74	.72	.60	.99	.70	1.94	1.34	4.19	2.95
H.	.64	.72	.81	.81	.64	.64	.85	.71	1.88	1.45	3.79	3.45
H.	.67	.70	.81	.76	.80	.67	1.02	.71	1.91	1.40	4.25	3.10
H.	.66	.65	.78	.75	.78	.65	.96	.66	1.68	1.39	4.06	3.04
Ave. .	.68	.67	.81	.77	.74	.64	.96	.70	1.85	1.40	4.07	3.14
L.	.63	.63	.82	.73	.64	.57	.78	.68	1.54	1.27	4.11	3.01
L.	.63	.64	.80	.81	.69	.67	.83	.77	1.71	1.75	4.05	3.65
L.	.72	.68	.89	.73	.77	.66	1.06	.74	1.89	1.34	4.20	3.07
Ave..	.66	.65	.84	.76	.70	.63	.89	.73	1.71	1.45	4.12	3.24

It is of interest to note that the amount of moisture in proportion to the dry weight of the Elberta fruit buds is greater than that of the Greensboro buds in almost every case. There are, however, a few exceptions. On November 8, the Greensboro values were greater for two of the trees on high ground and for one tree on low ground. The Greensboro values are also greater on December 6 and again on March 7 for this same tree growing on low ground. There are three cases in which the values of the Greensboro equal those of the Elberta: one on November 8 for a tree on low ground, one on December 6 for a tree on high ground, and one on January 7 for the same tree on high ground. There is no uniformity in the differences between trees receiving fertilizer treatments. Some differences are seen, but these are probably due to individual variations. No great differences are apparent between the ratio values of buds taken from trees growing on high ground and from those growing on low ground.

CONCLUSIONS

Attention is called to two points in these observations. First, there is a marked seasonal increase in the water content of fruit buds of the Elberta and Greensboro peach whether determinations from individual trees or from averages are considered. Second, as the season advances the difference between the water content of fruit buds of the Elberta and Greensboro peach becomes more marked, the values for the Elberta being the greater. Further investigation will be necessary to determine whether or not these differences are characteristic of the varieties, and to what extent such moisture content values are related to hardiness of these fruit buds. Attention is also called to the fact that of these varieties the Greensboro is considered more hardy with respect to winter injury, and to the fact that in this same variety the ratio of water content to dry weight of fruit buds is considerably less than that of the Elberta. Early spring is a critical time in the peach industry because of the "tender" condition of fruit buds. This same period is the time when the moisture content of the buds increases very rapidly.

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